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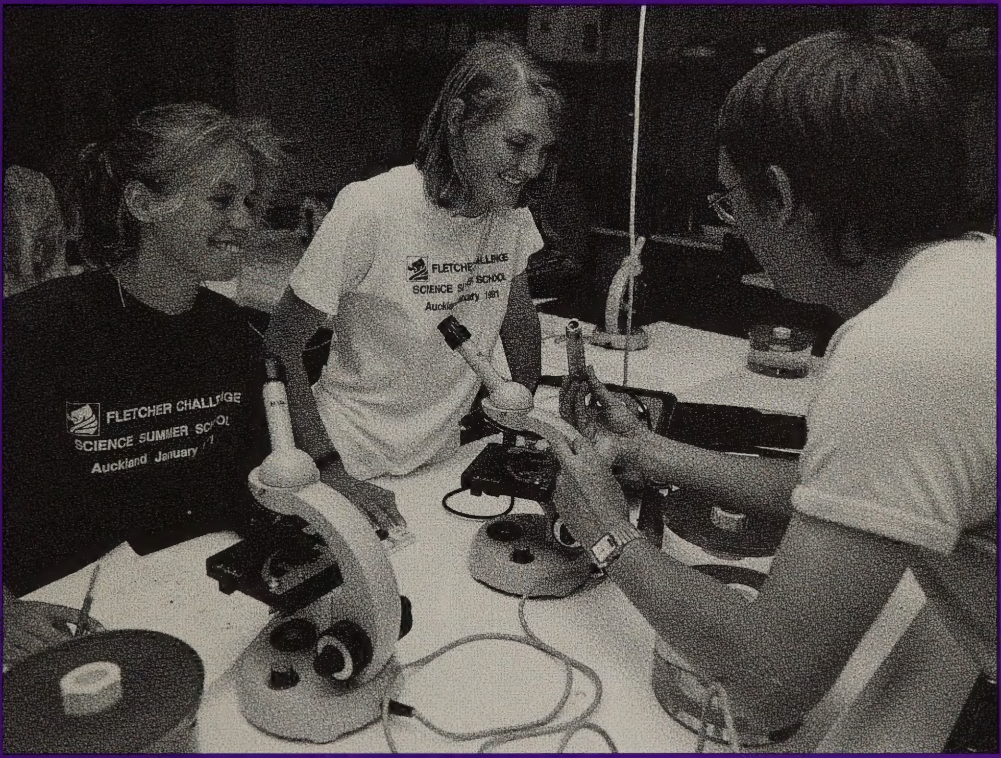
Survey of Attitudes to, and Understanding of, Science and Technology in New Zealand

Ministry of Research, Science and Technology,
Wellington, New Zealand

November 1991



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SURVEY OF ATTITUDES TO, AND UNDERSTANDING OF, SCIENCE AND TECHNOLOGY IN NEW ZEALAND

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1 EXECUTIVE SUMMARY

- A survey of attitudes to, and understanding of, science and technology in New Zealand has been undertaken by the Ministry of Research, Science and Technology.

- The survey was based on the response to a questionnaire comprising 38 questions about science and 16 questions about the respondent. The questionnaire contains some 'key' questions which have been used overseas as indicators of scientific literacy, attitudes and interest. There is also a range of other questions including many relevant to the New Zealand science scene.

- A sampling procedure was used to select prospective respondents to the questionnaire over a representative range of population groups, ages, rural/urban areas, etc. Some people did not wish to be interviewed, possibly because they felt they had no aptitude or interest in science. This may have created a bias in the survey (e.g. 11% of respondents had university degrees, compared to 4.5% in the Census). However, we do not see how any market research procedure, including those used in comparable studies overseas, could have avoided this element of self selection. A sample of 1012 people, about half of them men, about 10% Maori, between the ages of 15 and 65 were interviewed. 40% of the women were 'domestic'.

- The questionnaires were analysed and the results provided in tabular form. Two kinds of analysis were required:

    - Tabulation on a question-by-question basis. For instance, the percentage of correct answers to a given true/false question was tabulated together with information such as the ages, gender, educational qualifications of the respondents

    - Tabulation resulting from correlations between the replies of a given respondent to the various 'key' questions which build up the indices of scientific literacy, attitudes to science and interest in science in New Zealand.

- Four consultants were asked to comment on these findings and recommendations in a synthesised form are included here.

- The survey also comprises a method of comparing scientific literacy, attitudes and interest in New Zealand with those in three other countries (the UK, the USA and Canada). The consultant's report is included here in abbreviated form in the text and in its entirety in Appendix 1. The following major findings were obtained:

    - 10% (1 in 10) of New Zealand adults were found to be 'scientifically literate', this being defined as a 'threshold' measure of minimal understanding of the processes, terms and social impact of science. This figure is higher than that obtained in similar studies overseas,

    - 13% of New Zealand adults were found to be 'attentive' or interested in science. This figure is lower than that found overseas, and comprises a very low percentage of women.

    - Only 3% of New Zealand adults were both 'attentive' to science and scientifically literate. This is slightly higher than the situation overseas but it is still too low if decisions on science-related issues are to be made democratically.

    - It was also found that New Zealanders as a whole have a 'negative' attitude to science, similar to that in the UK. In both these countries those qualifiying as 'scientifically literate' had slightly more positive attitudes to science. By contrast, the attitudes to science in Canada and the USA were far more positive.

As discussed in Chapter 4 of this report, the survey as a whole suggests a fairly high degree of interest in science and technology in New Zealand, though it must be borne in mind that the sample of 1012 people surveyed had some element of self- selection. There was higher interest in areas of perceived relevance to the respondents' daily lives. Men, those with tertiary education and those in professional occupations, had the highest interest overall. Women were more interested and felt more informed in the health and biological science areas. There was some confusion as to what constituted the 'scientific method' and lack of distinction between science and technology. Half the respondents could not point to a significant scientific achievement in NZ in the last 10 years. The attitudes to such issues as the potential benefits or hazards of science and technology can be described as 'negative'. It was agreed, however, that science is important to the individual as 'consumer and citizen' and many were willing to learn more about science.

Implications for the media, for science education, and for women are summarised in Chapter 4.

As discussed in Chapter 5 of this report, the NZ estimate of 'scientific literacy' is higher than that obtained overseas using the same methodology; the number of 'attentives' is lower; and the number of people who were both 'scientifically literate' and 'attentive' is only about 3%, which is too low if decision-making on science related issues is to be democratic. It is suggested that national goals be set for an improvement of these values and that policy be devised to achieve these goals. Such policy could take into account the different demographic characteristics of the 'literate' and 'attentive' groups identified in the survey: the former were mainly middle-aged, professional men with tertiary education, while the latter spanned a wide range of age- groups and included a large proportion of people with little formal education; women were poorly represented in both groups. The attitudes to science in New Zealand were found to be 'negative', even among the 'scientifically literate' group. This is similar to the situation in the UK, whereas attitudes in Canada and the USA were more positive.

2. OBJECTIVES OF SURVEY

2.1 Overseas context

In 1988 a survey (1) of scientific literacy in the USA found that (2) "only about one in 18 US adults knows enough about the vocabulary and methodology of science to function effectively as a citizen and consumer when faced with decisions about scientific topics such as nuclear power, acid rain and health". The methodology used in the survey had been developed over a period of 10 years by Jon Miller, Director of the Northern Illinois University Public Opinion Laboratory. He found (1) no significant change in scientific literacy despite "...the continued growth of scientific achievement and the expanded impact of science and technology on our lives, our jobs and our culture during that decade."

The same methodology was used (3) in a parallel study in 1988 in the UK. The interview contents were coordinated to ensure maximum commonality between the studies. Remarkably similar patterns of response were found in the two countries. Miller concludes that: "The important point is that in two of the world's oldest and most prominent democracies, at least 9 out of 10 citizens lack the scientific literacy to understand and participate in the formulation of public policy in a very important segment of their national political agendas. .....we must begin to think about the programs and interactions needed to change these patterns of broad scientific illiteracy".

The studies were extended (4) to Canada in 1989, and similar estimates of scientific literacy were obtained. At this point the methodology was extended to define a new concept, the 'attentive' to science, namely a person who is interested and informed regarding science and technology policy. The authors of the report (4) state that it is the attentive citizens who are involved and/or politically active regarding science issues.

In all three countries it was found that only a small proportion of those 'attentive' to science were also scientifically literate. As a result, only 2 to 3% of adults were both interested in scientific issues and scientifically literate. It was felt to be imperative that scientific literacy be increased if democratic input to science issues is desired.

A method was also developed of categorising respondents' attitudes to science on a 5-point scale ranging from 'very negative' to 'very positive'. The three countries were found to have different attitudes to organised science, the attitude in the UK being 'negative', that in Canada being 'positive' and that in the USA more positive still. Those qualifying as scientifically literate had somewhat more positive attitudes than non-literates, but in the UK even the literate fraction had only marginally positive attitudes. By contrast, this fraction in the USA was very positive. A Gallup poll in the UK, recently reported by the 'Daily Telegraph' (5), gives graphic confirmation of a 'negative' attitude to science in that country: "...four people in ten say that they would definitely or probably sacrifice our existing high-tech civilisation in favour of some arcadian dream, and a mere one-third of those questioned spoke up for the benefits that science brings."

These overseas findings and concerns regarding public attitudes towards, interest in and understanding of science and technology were the impetus for a similar survey in New Zealand. A survey based on the same methodology as that used overseas was initiated by the Ministry of Research, Science and Technology in 1990.

2.2 Definition of indices of 'scientific literacy', 'attentiveness' and attitudes to science

Various kinds of 'literacy' can be defined, beginning with 'basic literacy' (the ability to read and write) and including 'mathematical literacy', 'computer literacy' and 'scientific literacy'. These are all threshold levels, representing the attainment of minimal skills. All are relative measures, depending on the perceptions and priorities of those who set the criteria for achievement at a given time.

The problem is two-fold: it is necessary to decide what requisite skills comprise 'literacy' in a given area, and it is necessary to design a questionnaire or other testing methodology which will establish whether the individual has these requisite skills.

The investigators overseas comment (1) that: "It is important to unerstand the continuing nature of this work. From the earliest stages of planning we have all been aware that our measures of scientific literacy are evolving and we must seek to develop better questions and indices."

The problem of defining 'scientific literacy' did not arise in the NZ survey. If NZ findings were to be compared with those overseas, the same definitions and methodology would have to be used here.

This meant that the NZ questionnaire had to contain, among many other items of interest, the same set of 'key' questions as were used overseas in evaluating indices of 'scientific literacy', 'attentiveness' and 'attitudes to organised science'. Some of these 'key' questions are 'open-ended', some are sets of 'true-false' statements, and some require evaluation of statements on scales ranging, for instance, from 'strongly disagree' to 'strongly agree'. The 'key' questions used in the NZ survey were the same, with one exception, as those used overseas.

The NZ survey also had to adopt the same method as used overseas to derive these indices from the responses to the 'key' questions. The definitions are as follows:

2.2.1 The term 'scientific literacy' is defined as a measure of the minimum abilities which an individual must have in order to function as a 'citizen and consumer'(1,2,4) in our modern technological society. The criteria used here were the same as those used in the overseas studies, namely minimal understanding of the scientific process (2 questions), minimal understanding of the basic scientific terms and concepts of science (9 questions), and minimal understanding of the impact of science on society (2 questions in NZ, 3 overseas). In order to qualify as 'scientifically literate', a respondent must score adequately in all three of these aspects of scientific understanding.

2.2.2. The term 'attentive' is defined (4,6) as a measure of the respondent's degree of interest in science and technology. 'Attentiveness' is measured in terms of the respondent's own stated interest in science, as well as evidence of this interest.

2.2.3. The acronym 'ATOSS' stands for 'Attitude to Organised Science Scale'. The ATOSS score is evaluated from the respondent's response to five attitudinal questions, on a 5-point scale ranging from 'strongly agree' to 'strongly disagree'. An ATOSS score of 3 or more indicates a 'positive' attitude to science. An ATOSS score of less than 3 indicates a 'negative' attitude.

2.3 NZ Questionnaire

The NZ survey needed to contain the same 'key' questions as used overseas for analysis of the various indices. The questionnaire also contained several questions particularly relevant to science in New Zealand. Demographic information was also required so that interest and ability in science could be related to ascribed characteristics of the sample population (age, gender, ethnicity) and achieved characteristics (level of education and occupation). The questionnaire comprised 38 questions about science and 16 questions about the respondent.

The survey has generated considerable information about science in NZ, and there is potential for re-use of the questionnaire and its associated methodology for future surveys. It is for example an important tool for continuing assessment of the NZ science scene, for monitoring changes in public awareness and attitudes to science and possibly for evaluating the 'scientific literacy', 'attentiveness' and 'attitudes to science' of various client groups, such as business, science teachers etc.

If the survey is repeated at a later date, some of these changes could be incorporated:

- a clearer distinction could be made between 'science' and 'technology'
- if an objective of the survey is assessment of attitudes to school science, specific relevant questions could be included
- the wording of the questions on the 'greenhouse effect' and 'ozone depletion' could be clarified as these issues and their causes are often confused
- 'social science' content could be included in the questionnaire
- radio listening habits could be included in the survey
- information regarding readership of 'scientific' magazines and of a Sunday newspaper could be clarified
- the omitted 'key' question in the criterion for 'scientific literacy' could be included in future surveys.

3. METHODOLOGY

The survey was carried out by a market research organisation (MRL). A sampling procedure was used to select prospective respondents to the questionnaire over a representative range of population groups, ages, rural/urban areas, etc, and interviews were sought.

Some people did not wish to be interviewed, possibly because they felt they had no aptitude or interest in science. This may have created a bias in the survey as it was found that about 11% of respondents had university degrees, compared to about 4% in the 1986 Census. However, we do not see how any market research procedure, including those used in the comparable studies overseas, could have avoided this element of self selection.

A sample of 1012 people, about half of them men, about 8% Maori, between the ages of 15 and 65 were interviewed. There are some divergences in this sample from the population characteristics in the 1986 Census: Maori and people in the 15-24 age group are somewhat under-represented and university graduates are over-represented. 40% of the women were 'domestic'.

The market research organisation then analysed the questionnaires and resultant database, presenting the results in tabular form. Two kinds of analysis were required:

- The responses were tabulated on a question-by-question basis. For instance, the percentage of correct answers to a given true/false question was tabulated together with information such as the ages, gender, educational qualifications of the respondents. This was completed mid-1990 and given to four consultants for interpretation. They have reported separately (7, 8, 9) on the implications of the survey for women, education and the media, respectively. An overview of these results was also produced (11). The findings of these consultants are summarised below (section 4).

- It was required that the responses of each respondent to the 'key' questions be correlated so that it could be decided if he/she met the criteria for being 'scientifically literate' or 'attentive' to science, and if his/her attitudes to science were 'positive' or 'negative'. These correlations were delayed, awaiting details of the methodology used overseas in comparative studies (1,3,4,6). The correlations have now been tabulated and the results have been analysed in the international context. The consultant's report is included here as Appendix 1 and the major results are summarised below (section 5).

4. OVERALL RESULTS OF THE SURVEY

The survey was completed mid-1990 and the tabulated responses to the questions, together with the demographic correlations, were given to four consultants for interpretation. They have reported separately (7,8,9) on the implications of the survey for women, education and the media, respectively. An overview of these results was also produced (11). The findings of these consultants are summarised here.

4.1 Degree of interest in science and technology

A higher level of interest in, and knowledge of, science and technology was shown in areas of direct concern to the individual respondent. Lack of interest in particular scientific topics was not a matter of general apathy or indifference to information and discovery, rather it related to the perceived lack of relevance of those topics to people's lives.

This finding is similar to that of a British study which commented (14) that 'people seem to understand science in the ways which they find useful, not because of any abstract value it may have as a cultural good. They may be ignorant in general but highly knowledgeable in specific areas, where they have shown great energy and resourcefulness finding what they need'.

Respondents were asked to say whether they were very interested, moderately interested, or not at all interested in each of ten topics appearing in the news. The topics were sports, politics, medical discoveries, new films, new inventions and technologies, scientific discoveries, international affairs, economic and business matters, local school issues, and agriculture or farming issues.

The scientific, technological and medical discoveries were rated the highest of the ten categories with about 47% saying they were very interested in them. The fact that all three topics were rated so highly supports the reliability of the finding. However, the fact that they exceeded even sports news (42%) may indicate that people gave high priority to what they thought they should be interested in, rather than what they actually were interested in. While politics, economics/business and international affairs make up the bulk of staple news in the daily paper, they rated well down the list in interest level.

The level of interest was rather higher than that indicated in a DSIR survey taken about the same time (12). There just 30% of the sample declared themselves very interested or extremely interested in science and technology. However, the framing of the question in the present survey in terms of 'new discoveries' may well have promoted greater interest than the DSIR survey's blander phrasing about `interest in science and technology'.

A similar pattern was found in the UK (15): medical discoveries attracted the highest level of interest, followed by new inventions and new technologies, and (in descending order) sport, new films and politics.

Interest was particularly high among professional and technical occupation groups and the university-educated, especially those with a science background. Women were less interested overall, but more interested in topics related to health and the biological sciences generally.

4.2 Feeling Informed About Science and Technology

Respondents were also asked how well-informed they felt about the same ten issues. In all areas bar sports and politics, the proportions feeling very well-informed were relatively low. For example, only 15% felt well-informed about new medical discoveries and new inventions and technologies while 13% felt well-informed about new scientific discoveries.

In the UK studies (18) it was found that interest and informedness matched fairly well for sport, politics and films; but for science, technology and medicine there was a substantial discrepancy, with only a minority of those who claimed they were very interested also claiming that they were very well-informed.

Respondents did not generally feel well-informed about scientific and technological topics. However, lack of information and understanding is not entirely the responsibility of the non- specialist public. Responses to questions about the real causes of environmental problems such as the greenhouse effect showed that the public is generally confused. Clear and accurate communication by journalists and scientists is required to improve understanding, along with a greater emphasis in the media on the causes of problems rather than their effects.

4.3 Knowledge of Science and Technology

The survey included questions designed to test respondents' knowledge in the areas of natural science, the health and biological sciences, environmental science, physical science and astronomy. (There were no questions about social science.)

The proportion of correct responses was similar to that reported in the overseas studies (15).

In the natural science area, a high proportion of correct answers was given for topics relevant to everyday life: for example, 'hot air rises' (99%), 'sunlight causes skin cancer' (97%).

Two questions were included on environmental science and both concerned the greenhouse effect. Although most people had heard of this effect, their knowledge of contributory factors was poor. All respondents, including university graduates, confused the factors contributing to the greenhouse effect and those causing damage to the ozone layer. Clearly there is need for increased knowledge of recent research in areas of current concern.

4.4 Understanding of 'the scientific method'

Respondents were asked to estimate their understanding of the term 'scientific study'. Overall, only 15% believed they had a clear understanding of the term, 63% thought they understood it in a general sense, while 22% felt they had little understanding or did not know.

Those who felt they had a 'clear understanding' or a 'general sense' of the meaning of 'scientific study' were then asked to explain what it meant to them, using a list of meanings supplied by the researchers.

A number of questions concerned the concept of theory and the status of scientific information. Over half the respondents (54%) saw a scientist's meaning for 'theory' as a 'hunch or idea'. The same proportion saw it as a 'well established explanation'. (More than one response could be recorded). When respondents were asked what meaning scientists attached to Einstein's theory of relativity and Darwin's theory of evolution they tended to see these specific theories as proven facts.

Finally, respondents were asked to explain the reasons for differences among scientists about their interpretation of scientific information. Respondents generally had an inductivist view of science in which the importance of 'facts' was promoted at the expense of theory and the scientist was, by implication, a detached observer.

Physical sciences such as chemistry, medicine and physics were seen as rather more 'scientific' than astronomy and biology and far more 'scientific' than psychology, astrology, history or economics.

High profile activities such as 'developing new medicines' and 'developing new space rockets' were seen as very scientific by most people although they have, in fact, a strong technological component. They were followed by 'finding out why hurricanes happen' and 'studying the workings of the human mind', activities which are likely to involve the proposal of new theories and greater understanding of the world, both characteristics of science. This suggests that respondents did not or could not distinguish between science and technology.

4.5 Scientific and Technological Achievements

Two questions explored respondents' knowledge of New Zealand's scientific and technological achievements and their perceptions of New Zealand's standing in relation to other technologically advanced countries. It was found that more than half the respondents did not know of any significant scientific or technological achievements in the last ten years, although the same proportion thought that in general New Zealand was 'keeping up well with most other technologically advanced countries.'

4.6 Attitudes to Scientists, Science and Technology

The most important aim of science and technology was felt to be: 'to learn more about the world' and the second most important aim 'to develop new and useful products'. A significant proportion of respondents valued the aim of job creation highly.

Attitudes to scientists, science and technology and science education were assessed through respondents' answers to 22 statements, overall agreement or disagreement being assessed by the scoring on a scale ranging from 1 to 5.

Although there was agreement with the statement that 'science and technology are making our lives healthier, easier and more comfortable', some negative attitudes to science are apparent. For instance, there was consensus that: 'scientists cannot be trusted to make the right decisions' 'ordinary people are not told enough about what scientists are doing', 'there are some good ways of treating sickness that medical science does not recognise', 'more jobs will be lost than created as a result of computers and factory automation' 'new inventions will not always be found to counteract any harmful consequences of technological development', 'the benefits of science are less than any harmful effects'

Respondents were thus pessimistic about the impact of science and technology on society and concerned about the harmful consequences of technological developments. The DSIR survey (12) found similar attitudes to the potential benefits and hazards arising from science and technology.

The survey suggests that 'trust me' statements by scientists are unlikely to be well received by the public. When the public regards scientists as doing something they disagree with or knowing something which should be publicly communicated, more than reassuring generalisations are needed.

There was agreement that science and science learning were important to the respondents in their daily lives and as citizens: 'if science knowledge is explained clearly, most people will be able to understand it,' 'it is important for me to know about science in my daily life', 'interested and informed citizens can often have some influence on government policies towards science and technology if they are willing to make the effort,' 'even if it brings no immediate benefits, scientific research which advances the frontiers of knowledge should be supported by the Government'. Thus people did want to be told about science and they believed they were capable of understanding if they were told clearly. Those groups with lower interest in science were strongest in believing that science can be understood if properly explained.

The public would like to see greater public involvement in decision-making about science and technology. People want to know what is going on in science, partly because of suspicion that they are not being told, but partly out of sheer interest in the things scientists find out.

4.7 Access to and Interest in Science and Technology in the Media

The survey addressed access to scientific and technological articles in the print media and on television.

Results indicate that two-thirds of the sample (64%) read a newspaper virtually every day; 13% read one three or four times a week and 13% only once or twice a week. 79% of those aged 55 years and over read the paper daily, compared with only half those under 25 years (48%). Readership was low outside the paid workforce. Only half those described as students, unemployed, beneficiaries or in domestic work read the paper daily. (The survey did not ask about radio listening habits.)

Claimed readership of science and technology magazines was highest among those with an educational or occupational background in the area. The most notable gap in readership was among women.

It was clear from the responses that many people are getting much of what they regard as scientific or technical information from generalist publications, particularly Time and the Reader's Digest. It is striking that so many respondents classed these publications as centrally about science and technology.

Respondents were specifically asked about two science programmes, 'Fast Forward' and 'Beyond 2000' and about 'Our World', a television nature programme. It is felt, however, that the reported viewing rates are less a reflection of the nature or quality of the programmes than of the channels on which they have been scheduled. TV1 generally has an older audience, compared with TV2's concentration on the younger audience. This suggests that the sectors of the population which do not seek out science and technology programmes or publications are quite prepared to watch them when they appear in the course of their usual media consumption.

Viewing of science and technology programmes was rather high compared with the DSIR survey (12). Just 27% of their respondents regularly watched science programmes. However, their survey did not distinguish different programmes. Their survey also found that women and younger people watched fewer science programmes than other people.

The survey indicates that the daily newspaper is a good medium for reaching men, older age groups and those in higher-status occupations. It is clearly much less appropriate as a means of targeting women, the young, and the disadvantaged: the unemployed, beneficiaries and ethnic minorities.

Some of these latter groups, for example young people, have been identified as particular targets for raising consciousness of science and technology, suggesting that media other than the daily newspaper must be used to reach them.

Similarly, magazine-reading patterns underlined the need for good science writing in local general-content magazines, in order to reach the non-specialist public.

With television, the survey shows the importance of placement and scheduling for reaching a particular audience. Mainline news programmes with their almost universally high audience numbers are a major means of reaching some sectors of society.

However, it is useful to remember that the means through which adults and young people acquire their scientific knowledge (radio, television, newspapers, magazines and books, libraries, museums, special science events, school, jobs or leisure activities) are not known, nor is the actual or appropriate balance between them (17).

4.8 Implications for women

Women in the sample were more poorly educated than the men. Although the same proportions (12%) gave senior secondary education as their highest qualification, fewer women than men had gone on to gain tertiary qualifications (34% compared with 40%). Almost the same proportion of women as men had some qualification in science (37% compared with 40%) but their qualifications tended to be at a lower educational level and were in the biological and health sciences rather than the physical sciences.

Women's perceptions of their scientific and technological knowledge were generally lower than those of men, although there was little difference in their success in answering questions with science and technology content. Feedback of information about their abilities in science and technology would enhance women's self-confidence and allow them to increase their contribution to science and society.

Fewer women than men read the newspaper every day, although women were more likely than men to visit a public library, art gallery, museum or zoo.

Many more men than women expressed interest in science (53% compared with 37%). Women were especially interested in the biological, health and environmental sciences and women were generally more knowledgeable than men in the first two areas. Only 38% of men were very interested in medical discoveries, compared with 59% of women. Men were particularly interested in new scientific discoveries and new inventions and technologies.

Women also felt better informed than men about medical discoveries while men felt better informed about scientific discoveries and new inventions and technologies.

More women than men tended to provide correct answers for topics concerning biological and health science while men scored better on physical science items concerning radioactivity, lasers, atomic structure, continental drift and the chemical nature of matter. A high proportion of women chose the 'don't know' category for most of these items which suggests that women are less confident of their scientific knowledge than men.

Women were better informed than men about heredity, but slightly less well informed than men about DNA, a topic which relates to the more 'scientific' areas of biochemistry and chemistry, in which women were generally less interested than men. Overall, women were less knowledgeable than men about astronomy and the physical sciences, traditionally a male preserve and the science area in which men were most likely to have qualifications.

With more men in the paid workforce and more women still with primary family responsibility, the balance between the genders of interest in science/technological discovery versus medical discovery becomes understandable.

Overall, women were slightly less successful at answering scientific and technological questions than men, though this appeared to be due in part to their lack of confidence in their knowledge of science and technology and their unwillingness to provide any answers at all.

4.9 Implications for Education

4.9.1 School Science

The survey showed that 'science' is seen mainly in terms of the physical sciences and 'making discoveries'. However, knowledge gained through school science was poorly retained into adulthood and the connections between science and technology, the natural world and everyday life were poorly and inaccurately perceived and understood. On the other hand, interest and eagerness to understand was highest where human beings and the natural world are clearly involved.

This suggests there is little case for continuing broad content coverage in school science curricula. There is rather a case for a curriculum concerned with learning skills to acquire science knowledge (where to go and whom to ask); learning about the nature, aims, limitations and conventions of science; and a small number of in-depth studies which capitalise on student interest and to some degree mirror the way in which they might acquire science knowledge in adult life. This approach has the potential to retain the confidence of students in their science abilities.

At present the various branches of science are taught in apparent isolation from each other, and from technological areas, fenced off by their reputations as more or less difficult, 'academic', 'abstract' and 'important'. It is important that efforts are made to dispel the off-putting mystique and disproportionate prestige of the physical sciences and technology, particularly new communications and information technology, and to demonstrate how these areas connect with the more familiar and approachable worlds of people and nature.

Appreciation of the nature of technology and of distinctions between technology and science was poor amongst survey respondents. There is a case for the introduction of technology education in schools which is concerned with the nature, aims and limitations of technology, gives students experience of technological problem-solving and familiarity with a range of technologies, and raises awareness of issues associated with technological developments.

Women's, and therefore presumably girls', lack of confidence in their scientific knowledge and understanding warrants particular attention. Women still need encouragement to become involved in mathematically-inclined science subjects and in science generally, and attention to content and presentation could help with this.

4.9.2 Higher Education in Science and Technology

Although, as suggested above, school science has little effect on subsequent science knowledge, the survey showed that tertiary science, and indeed tertiary education generally, did relate to improved science and technological knowledge. However, less than one-fifth of the sample had tertiary qualifications in science, and fewer women than men had science or indeed any qualifications at a tertiary level. The potential to increase public understanding in this way is clearly restricted to a few people. Though some information on choice of science at school (18) is available, investigation of choice of science and technology at tertiary level, especially with regard to potential students' views of the nature of science and technology, would be useful.

4.9.3 Adult Science Learning

The area of adult education has generated a number of thorough, useful studies and reports. These could be used in association with this survey so that adult educators can work in partnership with scientists and technologists to increase adult science learning. Given the high level of awareness that 'science is important', commercial media ventures - perhaps adapted from existing ones overseas - could also work well.

Participants in this study felt ill-informed about science and technology in areas of high interest, but confident that, given the opportunity, interested people could understand science and technology relevant to public debate. Some of the more marginalised groups - women, Maori, the less educated, the less skilled and those over 55 - were particularly confident of this. Clearly there is a pool of interest and talent for learning in science, especially among women who often curtailed their science education earlier than men.

To aid this process, it is important to clarify the key policies and goals across the whole area of science and technology education. What aspects of science and technology do New Zealanders need to understand, and what information and skills are essential? This survey suggests that the starting point must be understanding what a scientific approach means, and having an accurate perception of how everyday and mundane, in every sense, science and technology are.

5. Comparison of NZ and overseas indices of ‘scientific literacy’, ‘attentiveness’ and attitudes to science

Appendix 1 contains the full text of the consultant’s analysis (10) of the NZ indices of ‘scientific literacy’, ‘attentiveness’ and attitudes to science, together with comparison with overseas results. The major findings are summarised here.

5.1 Scientific literacy estimates for NZ

Table 1 shows the performance of the 1012 NZ respondents, and of their counterparts overseas, as regards ‘scientific literacy’.

The estimates of scientific literacy are given in the top row and the three contributory aspects are listed below, for all 4 countries and for ‘male’ and ‘female’ in the case of NZ. For a respondent to qualify as ‘scientifically literate’ he/she has to score adequately in each of the three contributory aspects. The criterion for the third aspect (*) is slightly different from that used overseas as one of three ‘key’ questions was omitted in NZ. Table 1 shows the results obtained when the NZ respondents had to score 2/2 on the remaining two questions.

The nett result is that the overall ‘scientific literacy’ is higher than that overseas (10% in NZ versus about 6% elsewhere). The gender difference in NZ is marked, with 14% of the men interviewed being scientifically literate, but only 6% of the women.

Although the NZ figure is relatively high (compared to other countries) it is still too low if one is to rely on the NZ public to make decisions on scientific policy, i.e. to ‘function democratically as citizens’ when faced with science issues.

Table 1: Scientific Literacy in Britain, Canada, and the United States, 1988 - 89, and in New Zealand, 1990.

	Britain %	Canada %	U.S. %	NZ %	(M %	F)
Estimate of scientific literacy	6.9	5.3	6.3	10.0	14	6
Understanding of scientific process	10.4	9.9	12.3	20.9	24	18
Understanding of scientific terms and concepts	31.1	37.7	31.8	47.6	61	35
Understanding of the impact of science and technology (*)	42.9	36.3	41.0	38.9	47	31
N	2009	2000	2041	1012	502	510

5.2. Who is scientifically literate?

The results regarding scientific literacy can be combined with the demographic data obtained in the survey. Comparison can then be made of the distribution of scientific literacy in the four countries, as shown in Table 2. (Table 2 can be interpreted as showing the probability that an individual in any of the groups will be scientifically literate.)

Only a rough comparison of educational qualifications in the different coutnries can be made. The attainment of a university degree has been equated to a 'baccalaureate' but 'high school' qualifications differ. All four countries show that men with tertiary training, aged about 40, are most likely to be scientifically literate.

5.3. Number of 'attentives' to science.

It was found that about 21% of respondents overseas qualify as 'attentive' to science. A total of 138 out of the 1012 NZ respondents qualified as 'attentive' to science, so the overall figure is 13.6%, comprising 19.9% for men and 7.5% for women.

Thus New Zealanders are less attentive to scientific issues than their overseas counterparts. About 40% of the NZ women were housewives who saw little science content in their lives.

Table 2: Distribution of Scientific Literacy in Britain, Canada and the United States, 1988-89, and New Zealand, 1990

(Percentages represent the fraction of scientifically literate respondents in each group)

		Britain	Canada	US	NZ
All Adults		6.9%	5.3%	6.3%	10%
Education	Less than High School	1.7%	.2%	.0%	1.1%
	High School Graduate	12.2%	3.0%	4.6%	4.6%
	Baccalaureate	38.1%	21.5%	21.2%	35%
Gender	Female	4.0%	3.6%	4.2%	5.9%
	Male	10.3%	6.9%	8.7%	14.1%
Age	18-29 years	9.1%	5.4%	7.5%	11%
	30-39 years	8.7%	7.4%	9.3%	20%
	40-49 years	9.6%	5.8%	6.5%	16%
	50-59 years	6.1%	3.7%	5.6%	12%
	60 or more years	2.2%	1.7%	2.3%	12%

5.4. Comparison between the 'scientifically literate' and 'attentive' groups.

It must be borne in mind that the total number of 'scientifically literate' people in the sample studied was only 99, and that the total number of 'attentive' people was only 138. It is impossible to draw statistically meaningful conclusions from such small samples. Some features of the two groups are so marked that they are of interest, nevertheless.

Details of similarities and differences are given in the consultant's report (10, Appendix 1) but the most striking differences are reproduced here as Graphs 1 and 2.

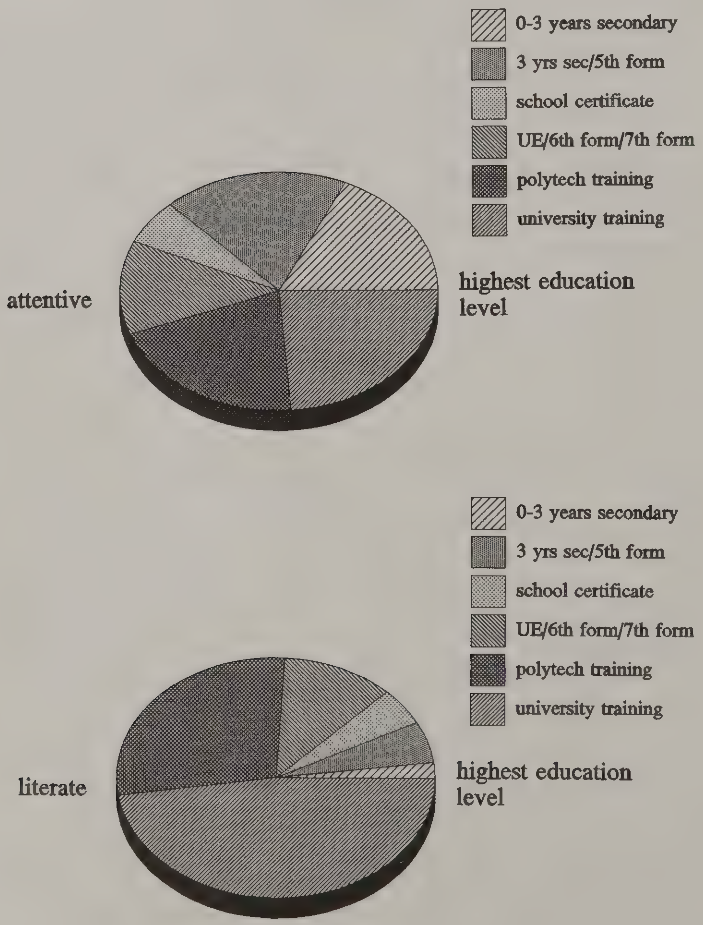
Graph 1 shows that the 'scientifically literate' group had a far higher level of education. Conversely, there was a very large proportion of people who had little education but who qualify as being 'attentive' to science. Graph 2 shows that the 'attentives' were fairly uniformly spread over all age groups, but that a large proportion of 'literates' were middle-aged.

5.5. How many people are both 'literate' and 'attentive'?

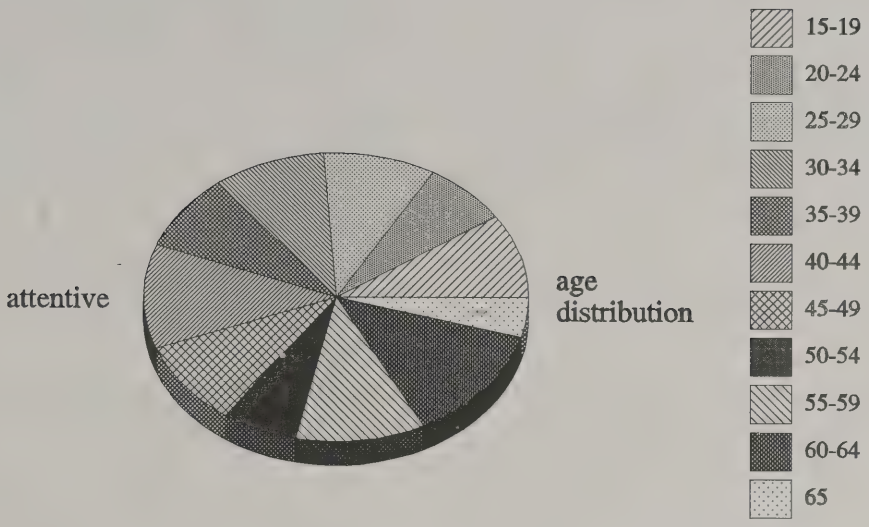
Only 3% of the NZ sample qualified as being both 'scientifically literate' and 'attentive' to science. Thus only this small fraction of New Zealand adults is both interested in scientific issues and qualified to hold informed discussions, or make an input to policy on science-related issues such as science priorities, genetic engineering, food irradiation or vivisection.

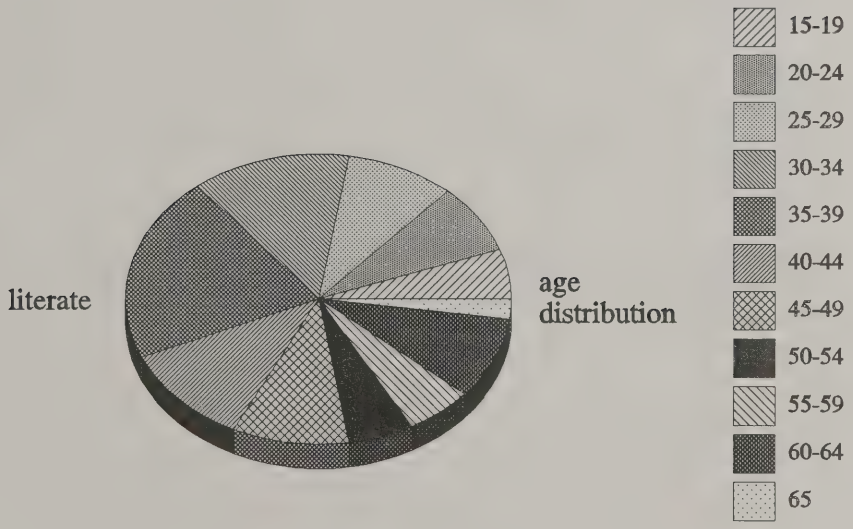
This figure is similar to that found overseas, where it was 2.8% in the UK, 1.8% in Canada and 2.4% in the USA. Overseas researchers (4) say that this is far too low for democratic decision making on scientific issues.

GRAPH 1



GRAPH 2


attentive
age distribution
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65


literate
age distribution
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65

5.6 Attitudes to science and technology in NZ

The scores for the 'Attitudes to Organised Science' (ATOSS) analyses in the four countries are shown in Table 3 .

It is seen that NZ attitudes are 'negative' to science, similar to those in the UK. By contrast, the other two countries have ATOSS scores above 3, reflecting 'positive' attitudes to science, that in the USA being most positive.

5.7. Do scientific literates have more positive attitudes to science?

Some demographic trends were found (10, Appendix 1) in the NZ ATOSS scores, although no group attained a value of 3, which is the minimum for a 'positive' attitude. Scientifically literate New Zealanders had slightly more positive attitudes to science, the score increasing from 2.4 to 2.8. This is again similar to the UK situation. However, in the other two countries the change was much more marked, with levels rising to 4.0 in Canada and 4.3 in the USA.

5.8 Conclusions regarding these indices

The scientific literacy in NZ was found to be relatively high when compared with overseas values. However, the figure of 10% still means that only 1 in 10 adults is 'scientifically literate', which is low in view of the scientific and technological nature of our modern world. Just as with these other kinds of literacy, it is necessary that national goals be set as to desirable values, and that policy be put in place to achieve these values.

The percentage of 'attentives', namely people who can show that they are interested in science, was found to be 13% in NZ, lower than that overseas, with women being less attentive than men.

Only about 3% of the sample population was found to be both 'scientifically literate' and 'attentive', which is comparable with the overseas figures, but far too low if decision-making on science-related issues is to be democratic.

Comparison between the demography of the 'attentive' and 'literate' groups identified in this survey can be interpreted in two ways:

- Only about a third of the 'scientifically literate' group is also 'attentive' to science. The 'scientifically literate group' comprises mainly men, in their 40's, in professional occupations. Ways could be sought of increasing the interest in science of these people.

- Only about a quarter of those 'attentive' to science are also 'scientifically literate'. The 'attentives' span a wide range of ages and occupations, and include a large proportion of people with little formal education. Adult education programmes to increase the scien-

Table 3: Attitudes toward Organised Science Scale (ATOSS): Scores for Britain, Canada, and the U.S., 1988 - 89 and for NZ 1990. (A score of 3 or more represents a 'positive' attitude to science)

		Britain	Canada	U.S.	NZ
Attitude towards Organised Science Scale	0	6	3	3	7
	1	18	11	5	24
	2	30	20	13	30
	3	27	24	21	22
	4	14	24	32	13
	5	5	21	26	3
Mean ATOSS Score		2.40	3.17	3.53	2.37
Standard Deviation from the mean		1.26	1.39	1.29	1.11
Standard error of the mean		.03	.03	.03	0.04
N =		2009	2000	2041	1012

tific literacy of these interested people would seem indicated.

Women were notably less 'scientifically literate' and 'less attentive to science' than men. Any programmes to increase awareness and informedness about science should try to be accessible to women in particular.

6. CONCLUSIONS

As discussed in Chapter 4 of this report, the survey as a whole suggests a fairly high degree of interest in science and technology in New Zealand, though it must be borne in mind that the sample of 1012 people surveyed had some element of self- selection. There was higher interest in areas of perceived relevance to the respondents' daily lives. Men, those with tertiary education and those in professional occupations, had the highest interest overall. Women were more interested and felt more informed in the health and biological science areas. There was some confusion as to what constituted the 'scientific method' and lack of distinction between science and technology. Half the respondents could not point to a significant scientific achievement in NZ in the last 10 years. The attitudes to such issues as the potential benefits or hazards of science and technology can be described as 'negative'. It was agreed, however, that science is important to the individual as 'consumer and citizen' and many were willing to learn more about science. Implications for the media, for science education, and for women are summarised in Chapter 4 and some recommendations made there and in the consultants' complete reports (7,8,9,).

As discussed in Chapter 5 of this report, the NZ estimate of 'scientific literacy' is higher than that obtained overseas using the same methodology; the number of 'attentives' is lower; and the number of people who were both 'scientifically literate' and 'attentive' is only about 3%, which is too low if decision-making on science related issues is to be democratic. National goals could be set for an improvement of these values and that policy be devised to achieve these goals. Such policy could take into account the different demographic characteristics of the 'literate' and 'attentive' groups identified in the survey: the former were mainly middle-aged, professional men with tertiary education, while the latter spanned a wide range of age- groups and included a large proportion of people with little formal education; women were poorly represented in both groups. The attitudes to science in New Zealand were found to be 'negative', even among the 'scientifically literate' group. This is similar to the situation in the UK, whereas attitudes in Canada and the USA were more positive. It may be relevant to investigate the situation in Australia, which is a close neighbour with strong cultural ties, and a combined approach be considered.

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APPENDIX 1

Indices of Scientific Literacy, Attitudes and Attentiveness in New Zealand, the UK, Canada and the USA

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for the Ministry of Research, Science and Technology

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1. INTRODUCTION

A survey of attitudes to, and understanding of, science and technology in New Zealand has been undertaken by the Ministry of Research, Science and Technology. The survey was based on the response to a questionnaire comprising 38 questions about science and 16 questions about the respondent. The range of questions included many relevant to the New Zealand science scene as well as groups of 'key' questions which had been used overseas to give indices of scientific literacy, attitudes and interest. It is these indices which are discussed here.

2. METHODOLOGY

2.1 Definition of terms

The 'key' questions are of various types. Some are 'open-ended', requiring acceptable responses within given limits. Some are 'true/false' questions about scientific facts. Some require that the respondent rank statements about science, for example on a scale ranging from 'strongly agree' to 'strongly disagree'. The responses to the 'key' questions allow three indices to be extracted:

2.1.1. The term 'scientific literacy' is defined as a measure of the minimum abilities which an individual must have in order to function as a 'citizen and consumer'(3) in our modern technological society. It is a relative measure, depending on the perceptions and priorities of the person designing the questionnaire. The criteria used here were the same as those used in the overseas studies, namely minimal understanding of the scientific process, the basic scientific terms and concepts of science, and the impact of science on society. In order to qualify as 'scientifically literate', a respondent must score adequately in all three of these aspects of scientific understanding.

2.1.2. The term 'attentive' is defined (2) as a measure of the respondent's degree of interest in science and technology. 'Attentiveness' is measured in terms of the respondent's own stated interest in science, as well as evidence of this interest.

2.1.3. The acronym 'ATOSS' stands for 'Attitude to Organised Science Scale'. The ATOSS score is evaluated from the respondent's response to five attitudinal questions, on a 5-point scale ranging from 'strongly-agree' to 'strongly disagree'. An ATOSS score of 3 or more indicates a 'positive' attitude to science. An ATOSS score of less than 3 indicates a 'negative' attitude.

3. RESULTS

Seven analyses were carried out and each is discussed separately below.

3.1. Determination of the 'scientific literacy' of the NZ sample, and comparison with overseas results.

Table 1 shows the performance of the 1012 NZ respondents, and of their counterparts overseas, as regards 'scientific literacy'.

The estimates of scientific literacy are given in the top row and the three contributory aspects are listed below, for all 4 countries and for 'male' and 'female' in the case of NZ. For a respondent to qualify as 'scientifically literate' he/she has to score adequately in each of the three contributory aspects.

The criterion for 'understanding of the scientific process' was an acceptable 'open-ended' definition together with correct response to a test question.

The criterion for 'understanding of basic scientific terms and concepts' was a score of at least 6/9 on nine questions of various types.

A problem arose, however, regarding the criterion for 'understanding of the impact of science and technology*'. The overseas criterion was a score of 2/3 on three questions, but one of these questions was inadvertently omitted from the NZ questionnaire. Several procedures were attempted as a way of evaluating the effect of this omission. An alternative third question was substituted, but it is only a matter of opinion whether this substitute is equivalent in scope and difficulty to the question omitted. The NZ score still remained as good as, or better than, the overseas scores when different procedures were used with a substitute question. Table 1 shows the results obtained when the respondents had to score 2/2 on the remaining two questions.

It can be seen that NZ respondents scored much better than their overseas counterparts as regards 'understanding of the scientific process' and 'understanding of scientific terms and concepts'. The NZ score for the third aspect, 'understanding of the impact of science and technology', using the slightly different criterion from that used overseas, is much the same as the overseas scores.

The nett result is that the overall 'scientific literacy' is higher than that overseas (10% in NZ versus about 6% elsewhere). The gender difference in NZ is marked, with 14% of the men interviewed being scientifically literate, but only 6% of the women.

Table 1: Scientific Literacy in Britain, Canada, and the United States, 1988 - 89, and in New Zealand, 1990.

	Britain %	Canada %	U.S. %	NZ %	(M %	F)
Estimate of scientific literacy	6.9	5.3	6.3	10.0	14	6
Understanding of scientific process	10.4	9.9	12.3	20.9	24	18
Understanding of scientific terms and concepts	31.1	37.7	31.8	47.6	61	35
Understanding of the impact of science and technology *	42.9	36.3	41.0	38.9	47	31
N	2009	2000	2041	1012	502	510

3.2. Who is scientifically literate?

The results regarding scientific literacy can be combined with the demographic data, as shown, for example, in Table 2.

Fairly broad educational groupings have been made here, the third group implying some tertiary training, not necessarily the attainment of a degree or diploma. Some comparison can then be made of the distribution of scientific literacy in the four population groups, as shown in Table 3. (Table 3 can be interpreted as showing the probability that an individual in any of the groups will be scientifically literate.)

Only a rough comparison can be made since the different countries have different educational qualifications. The value of 20.6% (indicated by asterisks on Table 3) is obtained from the grouping shown in Table 2, namely people with 'some tertiary training'. This value becomes 28% if only 'some University training' is used here for comparison with the overseas education level. It is about 35% if the percentage with university degrees is used.

Table 2: Variation of Scientific Literacy with Highest Educational Level Reached (percentages repesent the fraction of scientifically literate respondents in each educational group)

Total	O - 3 years Sec.	3yrs Sec/ 5th Form	School Certificate	UE 6th Form/ 7th Form	Some Polytechnic Training	Some University Training
1012	178	203	117	117	185	188
99	2 1.1%	4 2.0%	5 4.3%	11 9.4%	25 13.5%	52 27.7%
	1.1 %	4.6%			20.6%	

Table 3: Distribution of Scientific Literacy in Britain, Canada and the United States, 1988-89, and New Zealand, 1990

(Percentages represent the fraction of scientifically literate respondents in each group)

		Britain	Canada	US	NZ
All Adults		6.9%	5.3%	6.3%	10%
Education	Less than High School	1.7%	.2%	.0%	1.1%
	High School Graduate	12.2%	3.0%	4.6%	4.6%
	Baccalaureate	38.1%	21.5%	21.2%	**20.6%
Gender	Female	4.0%	3.6%	4.2%	5.9%
	Male	10.3%	6.9%	8.7%	14.1%
Age	18-29 years	9.1%	5.4%	7.5%	11%
	30-39 years	8.7%	7.4%	9.3%	20%
	40-49 years	9.6%	5.8%	6.5%	16%
	50-59 years	6.1%	3.7%	5.6%	12%
	60 or more years	2.2%	1.7%	2.3%	12%

All four countries show that men with tertiary training, aged about 40, are most likely to be scientifically literate.

3.3. Number of 'attentives' to science.

Those respondents who display a high level of interest in science, who develop a sense of being well informed and who maintain a pattern of current information acquisition, are referred to as being 'attentive' to science. It was found that about 21% of respondents overseas qualify as 'attentive' to science. A total of 138 out of the 1012 NZ respondents qualified as 'attentive' to science, so the overall figure is 13.6%, comprising 19.9% for men and 7.5% for women

3.4. Comparison between the 'scientifically literate' and 'attentive' groups.

It must be borne in mind that the total number of 'scientifically literate' people is only 99, and that the total number of 'attentive' people is only 138. It is impossible to draw statistically meaningful conclusions from such small samples. Some features of the two groups are so marked that they are of interest, nevertheless.

Graphs 1 to 11 (*PP33-38*) show comparisons between the 'attentives' and the 'literates'. Graphs 1 to 6 show areas in which the two groups are similar and Graphs 7 to 11 show areas in which there are marked differences.

Similarities between 'attentives' and 'literates':

Graph 1: Men predominate in both groups
Graph 2: Europeans predominate in both groups
Graph 3: Neither group is dominated by people whose parents had science backgrounds
Graph 4: Although the percentage of people who were employed varied between the two groups (see Graph 10), of those who were employed, most had jobs with science content
Graph 5: Although the percentage of people who had studied science varied between the two groups (see Graph 8), of those who had done so, the same balance of science subjects had been studied
Graph 6: Most of the people in both groups live in main urban areas.

Differences between 'attentives' and 'literates':

Graph 7: The 'literates' have a far higher level of education. On the contrary, there is a very large proportion of people who have little education but who qualify as being 'attentive' to science.
Graph 8: More of the 'literates' have science qualifications
Graph 9: The 'attentives' are fairly uniformly spread over all age groups, but the 'literates' are middle-aged.
Graph 10: The 'literates' tend to be 'professional' whereas the 'attentives' come from a wide range of occupations
Graph 11: There are most attentives' in the South Island, most 'literates' in the lower North Island.

Graph 7 is the only one which can be compared with overseas data. It shows that about 77% of NZ 'literates' had some tertiary training. This can be compared with the information (3) that about 40% of British 'literates' and about 60% of 'literates' in Canada and the USA, had 'baccalaureates'. In all four countries the 'literate' group is therefore dominated by people with tertiary education. It is interesting that about 15% of the British 'literates' had less than 'high school' education. None of the people in this category were literate in the USA and Canada. The educational situation in NZ is shown in Graph 7.

3.5. How many people are both 'literate' and 'attentive'?

The comparisons in Graphs 1 to 11 are interesting in themselves, and have implications for adult education, science education, etc, as discussed below. They also raise the question: how many people in NZ qualify as being both 'literate' and 'attentive'?

Graph 12 (p) shows the proportion of attentives who are also scientifically literate. Only 3% of the NZ population qualifies as being both interested in science and able to understand scientific issues. This figure is similar to that found overseas, where it was 2.8% in the UK, 1.8% in Canada and 2.4% in the USA.

3.6 ATOSS scores

The scores for the 'Attitudes to Organised Science' (ATOSS) in the four countries are shown in Table 4

Table 4: **Attitudes toward Organised Science Scale (ATOSS): Scores for Britain, Canada, and the U.S., 1988 - 89 and for NZ 1990. (A score of 3 or more represents a 'positive' attitude to science)**

		Britain	Canada	U.S.	NZ
Attitude towards Organised Science Scale	0	6	3	3	7
	1	18	11	5	24
	2	30	20	13	30
	3	27	24	21	22
	4	14	24	32	13
	5	5	21	26	3
Mean ATOSS Score		2.40	3.17	3.53	2.37
Standard Deviation from the mean		1.26	1.39	1.29	1.11
Standard error of the mean		.03	.03	.03	0.04
N =		2009	2000	2041	1012

It is seen that NZ attitudes are 'negative' to science, similar to those in the UK. By contrast, the other two countries have ATOSS scores above 3, reflecting 'positive' attitudes to science, that in the USA being most positive.

3.7. Do scientific literates have more positive attitudes to science?

Some demographic trends were found in the NZ ATOSS scores, although no group attained a value of 3, which is the minimum for a 'positive' attitude. The minor variations in attitude across the whole population can be summarised as follows:

Gender: Men 2.5, women 2.3
Age group: 15-19 most positive (at 2.6), 50-54 least positive (at 2.3)
Occupation: Professional most positive (at 2.7), domestic least positive (at 2.2)
Highest education level: University most positive (at 2.7), 0-3 yrs secondary least positive (at 2.1)
Science exams passed: the group which had passed any science exams was more positive (2.6) than the group with no exams (2.3)
Ethnic origin: Europeans were more positive (2.4) than Maori (2.0)

The ATOSS scores of scientifically literate (as opposed to nonliterate) New Zealanders were also determined. Scientifically literate New Zealanders had slightly more positive attitudes to science, the score increasing from 2.4 to 2.8. This is again similar to the UK situation. However, in the other two countries the change was much more marked, with levels rising to 4.0 in Canada and 4.3 in the USA.

4. CONCLUSIONS

The questionnaire used in this survey, based on that used overseas by Miller(2) and Miller and Einsiedel (3)contains, among many others, a set of 'key' questions. Responses to these questions can be correlated and used for the extraction of three indices which reveal the respondents' understanding of, attitudes towards, and interest in science. These indices are:

- 'scientific literacy': a threshold measure defining the minimal level at which an individual can function as 'consumer and citizen' in our technological society.

- 'attentiveness': a measure of the individual's interest in science and technology.

- 'ATOSS' or 'attitude to organised science scale': a scale ranging from O to 5 such that a value of 3 or more indicates a 'positive' attitude towards science.

Because the NZ study used the same questions (with one exception) as those used overseas, as well as the same method of analysing the data, comparisons can be drawn between NZ, the UK, Canada and the USA.

It was found that 10% (1 in 10) of New Zealand adults were 'scientifically literate'. Although this figure is higher than that obtained in similar studies overseas, it is still too low, since decisions on science related issues cannot be made democratically if only 10% of adults are qualified to participate.

Furthermore, of this scientifically literate 10%, not everyone expressed an interest in science. Only 3% of New Zealand adults were both 'attentive' to science and scientifically literate. This is similar to the situation overseas. In New Zealand, women were far less 'attentive' than men.

It was also found that New Zealanders as a whole have a 'negative' attitude to science, similar to that in the UK. In both these countries those qualifying as 'scientifically literate' had slightly more positive attitudes to science. By contrast, the attitudes to science in Canada and the USA were far more positive.

Differences between the 'attentive' and 'literate' groups identified in this survey can be interpreted in two ways:

- Only about a third of the 'scientifically literate' group is also 'attentive' to science. The 'scientifically literate group' comprises mainly men, in their 40's, in professional occupations. Ways could be sought of increasing the interest in science of these people.

- Only about a quarter of those 'attentive' to science are also 'scientifically literate'. The 'attentives' span a wide range of ages and occupations, and include a large proportion of people with little formal education. Adult education programmes to increase the scientific literacy of these interested people would seem indicated.

Women were notably less 'scientifically literate' and 'less attentive to science' than men. Any programmes to increase awareness and informedness about science should try to be accessible to women in particular.

5. RECOMMENDATIONS CONCERNING THESE INDICES

As a result of this survey it is recommended:

i) that it be noted that the New Zealand population has been found to have a 'negative' attitude, and a low level of attentiveness, to science, and that the level of scientific literacy, although higher than that overseas, is still too low for democratic, informed decision making on science related issues such as science priorities, genetic engineering, food irradiation or vivisection.

ii) that information be sought on indices of 'computer literacy' and 'functional literacy' (ie, reading skills) in NZ and overseas, in order to put these findings in a broader educational context.

iii) that goals be set nationally for altering the negative attitudes and low level of attentiveness to science (particularly among women) which have been revealed in this work, as well as for attaining a higher value of scientific literacy.

iv) that policy be made for means of attaining these goals.

v) that the survey be used again as a tool for ascertaining the scientific literacy, attentiveness and ATOSS scores of various important client groups such as:

- a similar NZ sample to the present one, in a few years' time when remedial measures have been undertaken
- school teachers/science teachers
- managers of businesses
- all those involved in making decisions related to NZ science policy.

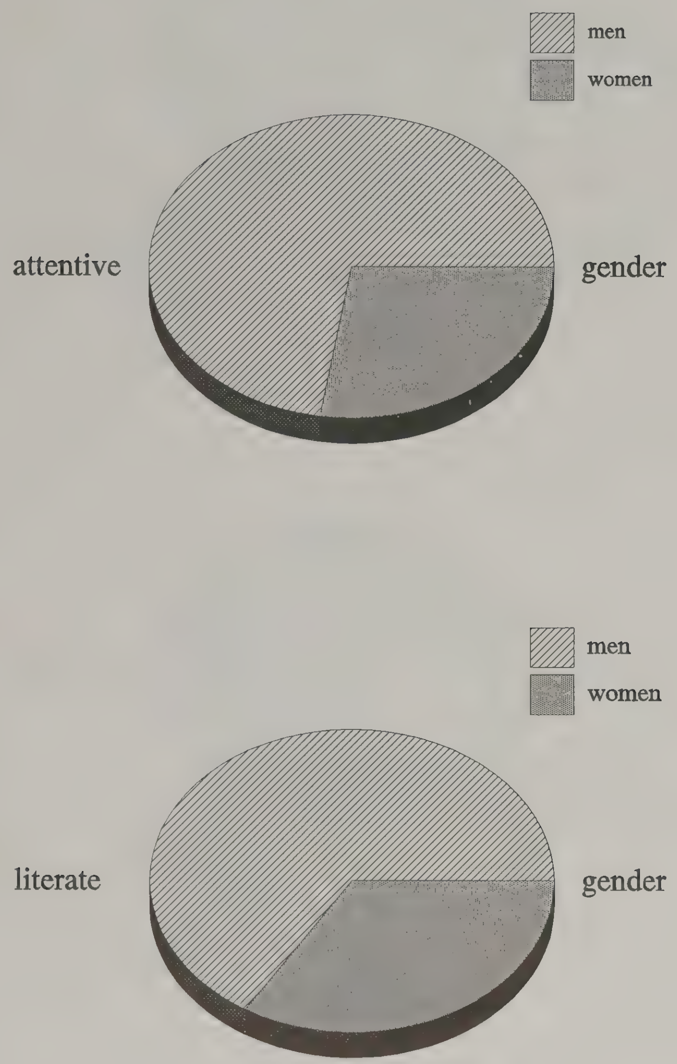
6. REFERENCES

1. Public Attitudes towards and Understanding of Science and Technology in New Zealand: An Overview: A. Gray, A. Else and H. McQueen, (1990)

2. Miller, Jon D, Personal communication

3. 'Scientific Literacy in Britain, Canada and the United States', Miller, J D and Einsiedel, E F (Ms submitted for publication)

GRAPH 1



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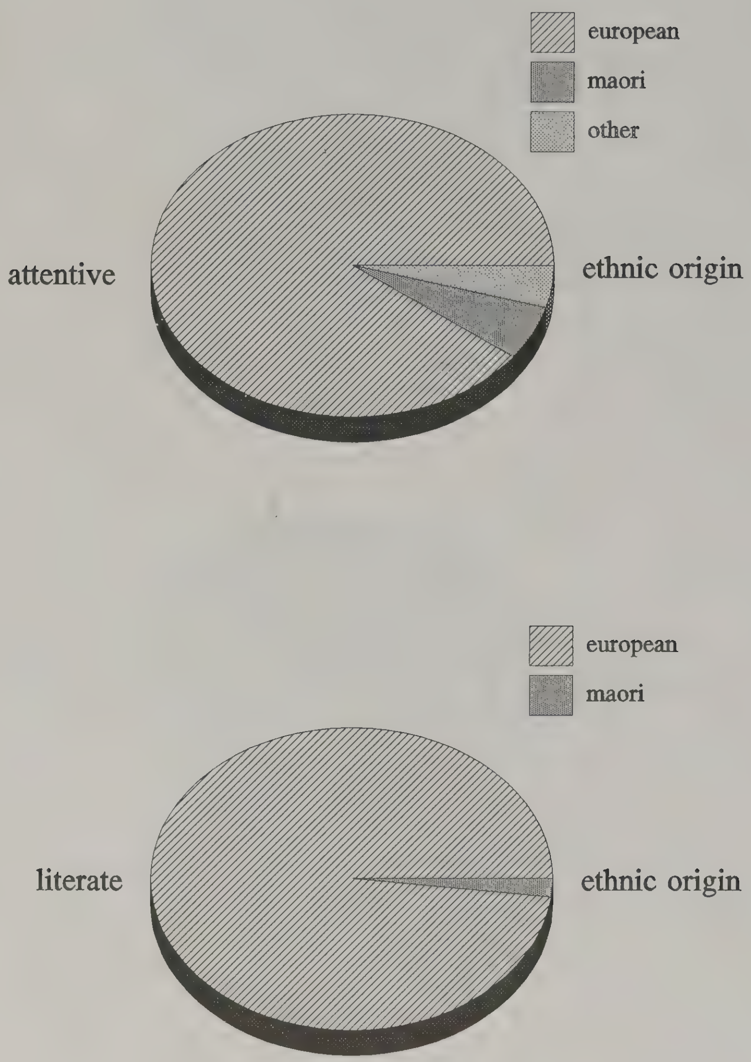

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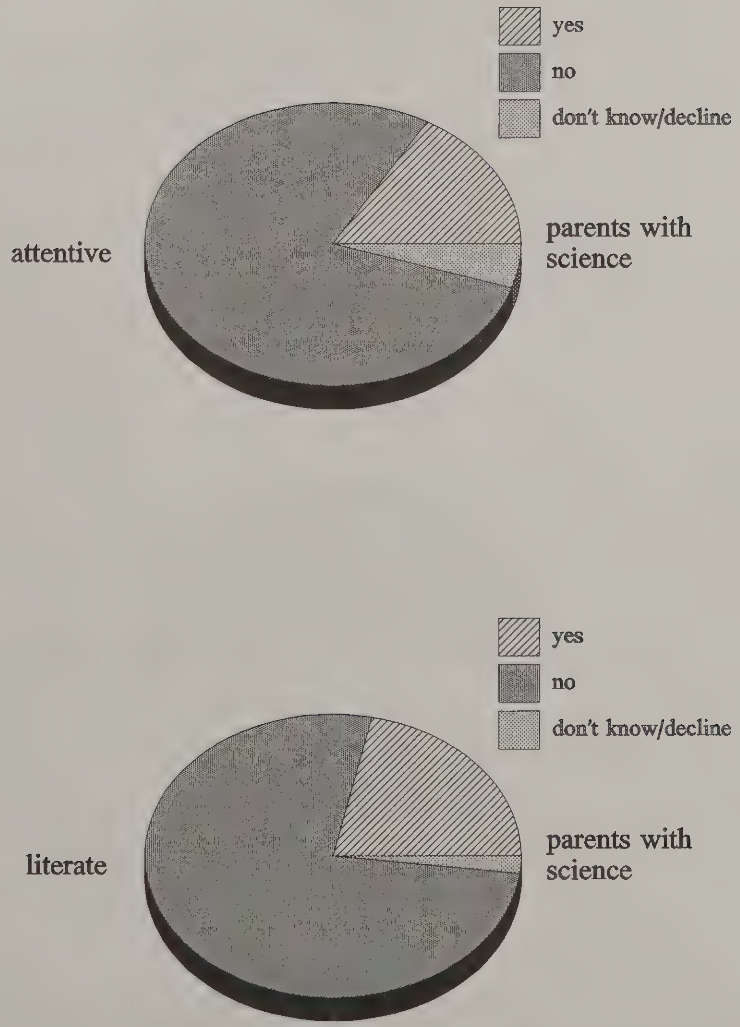

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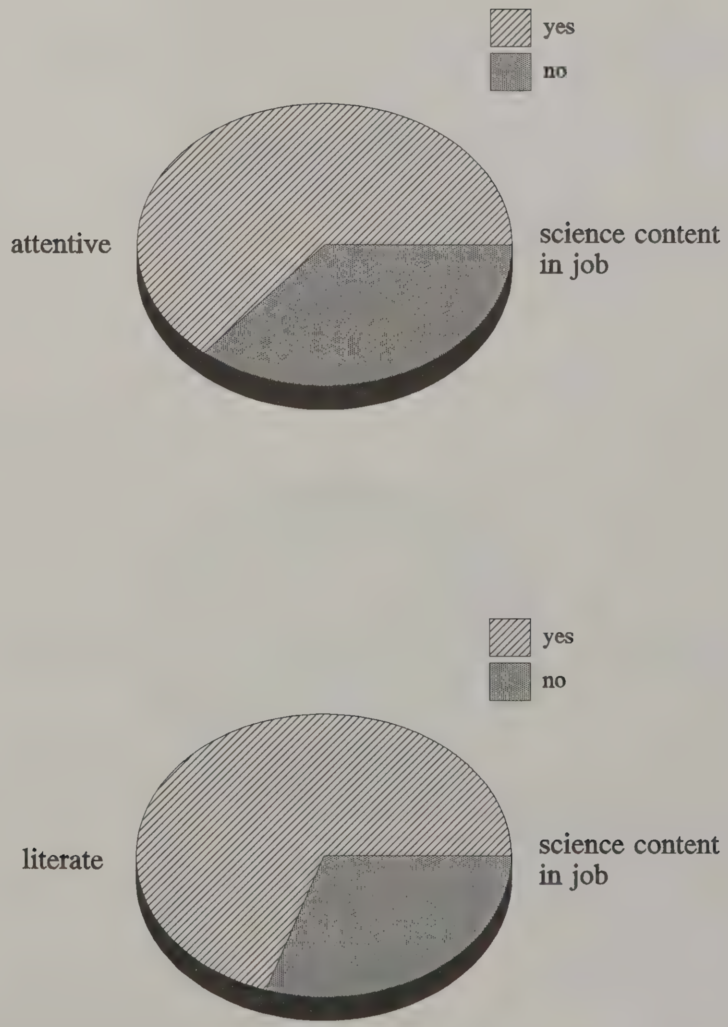

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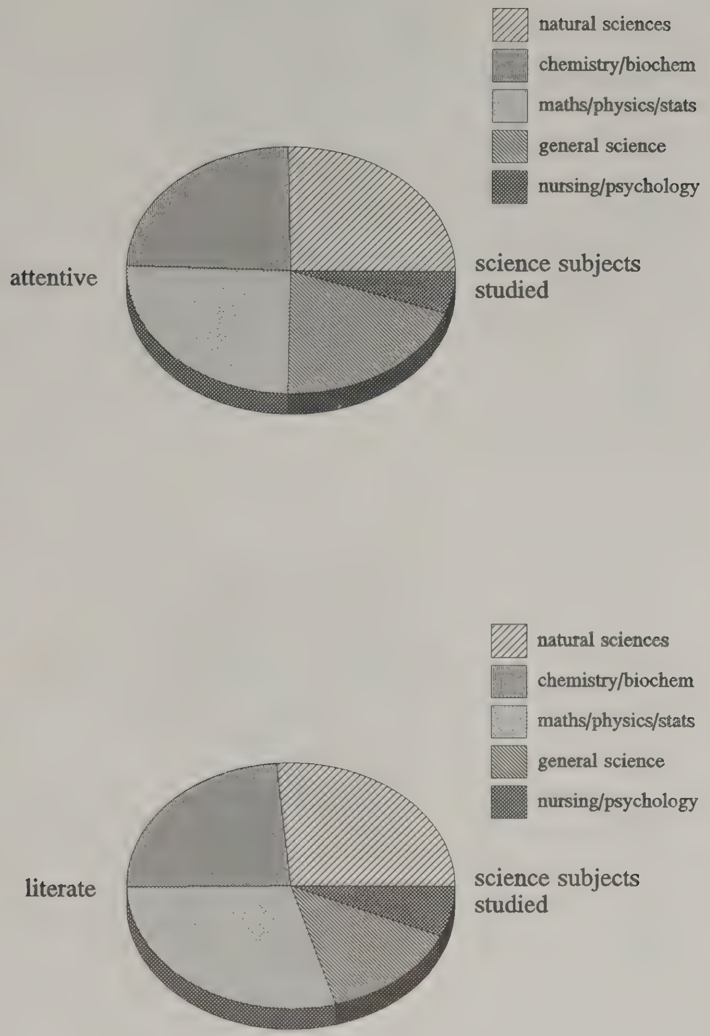

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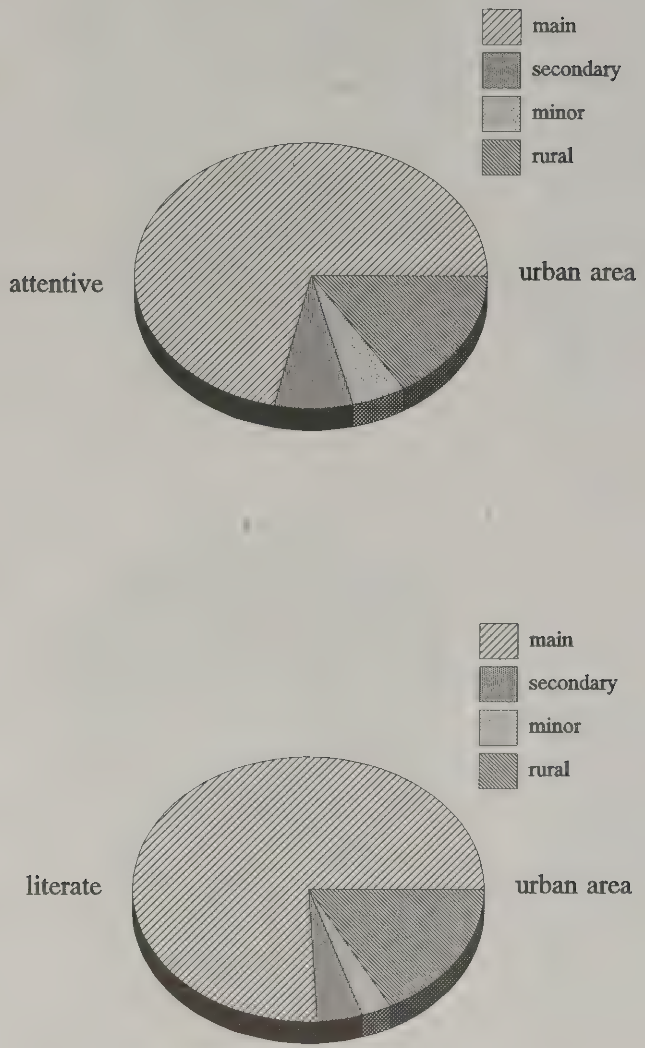

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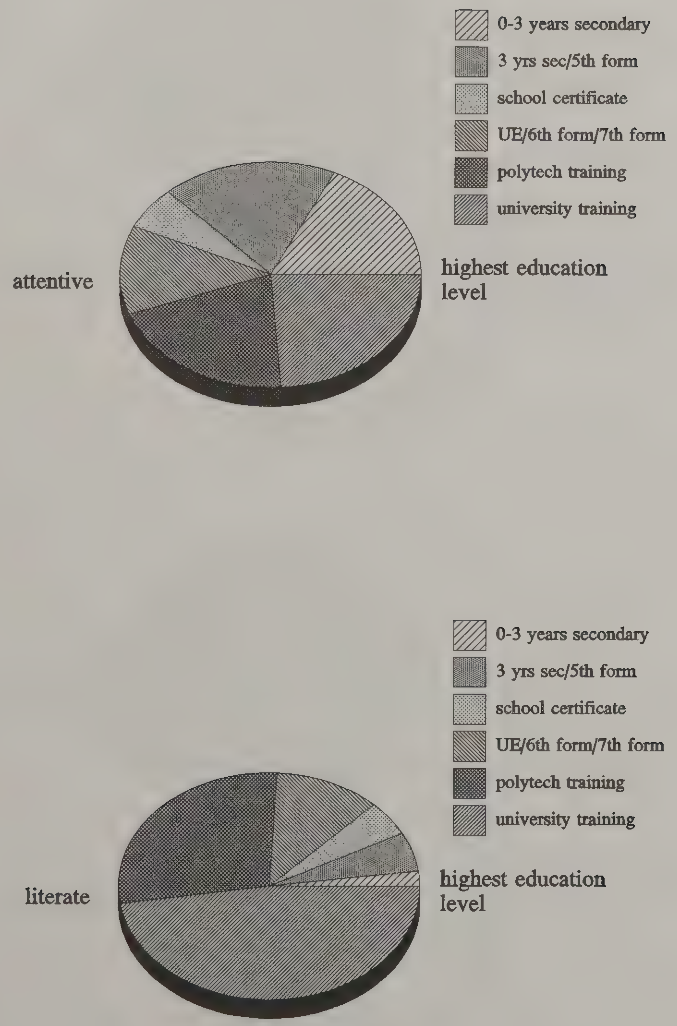

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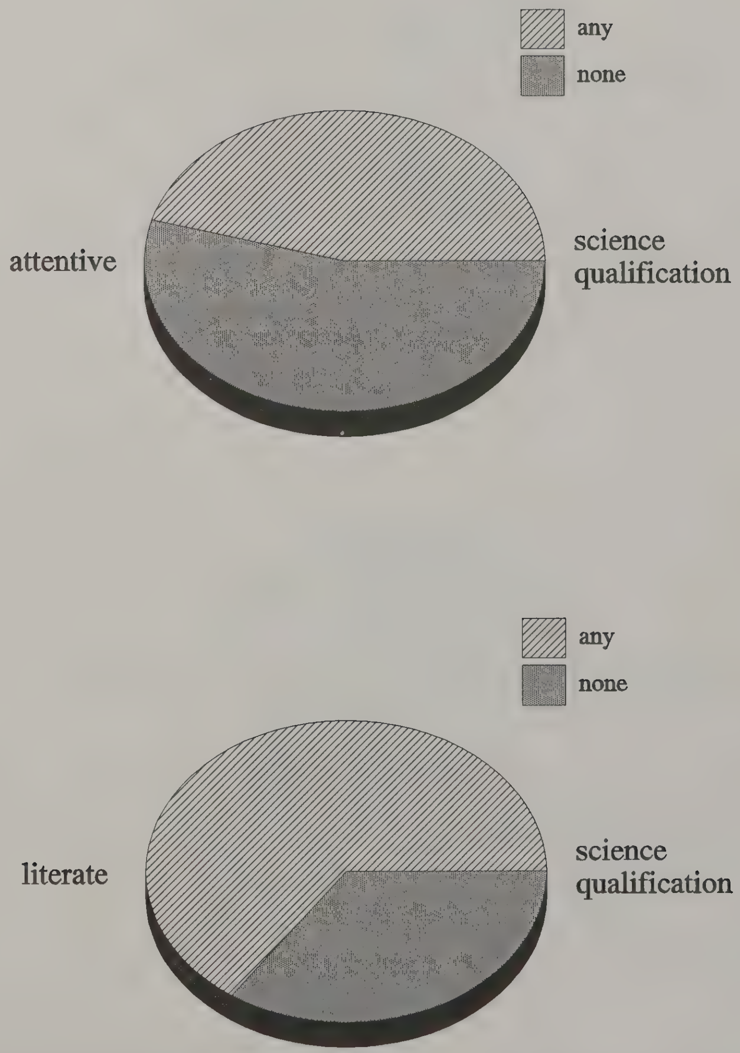

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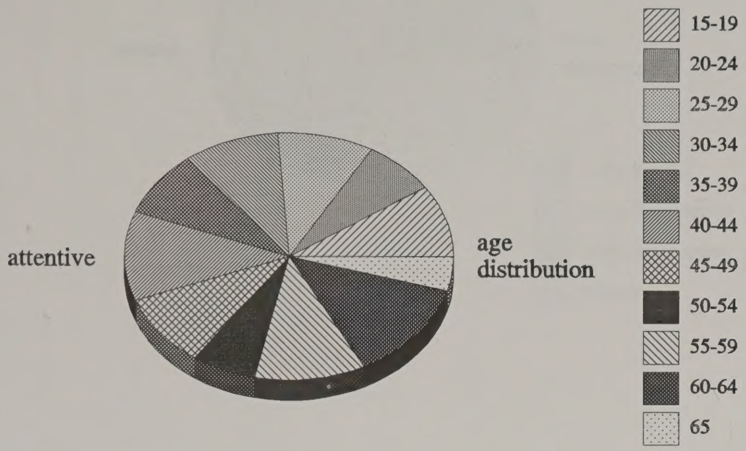

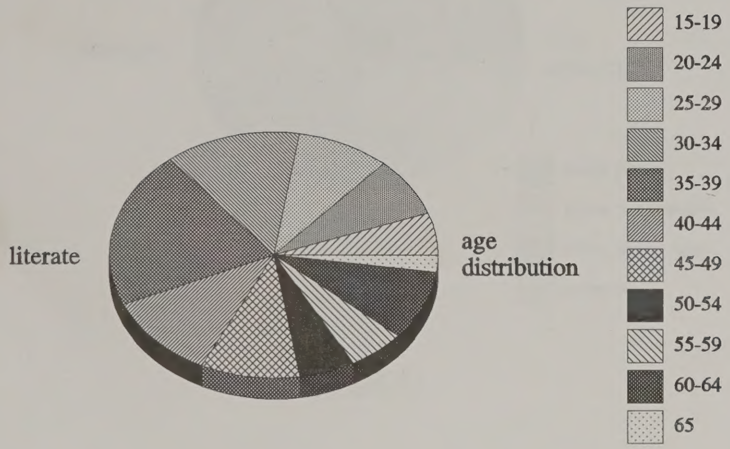

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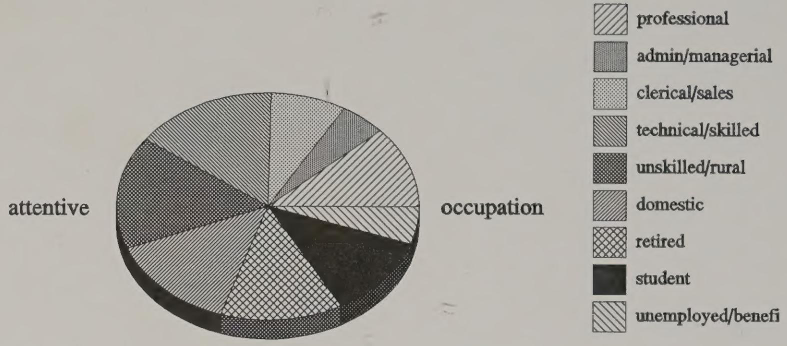

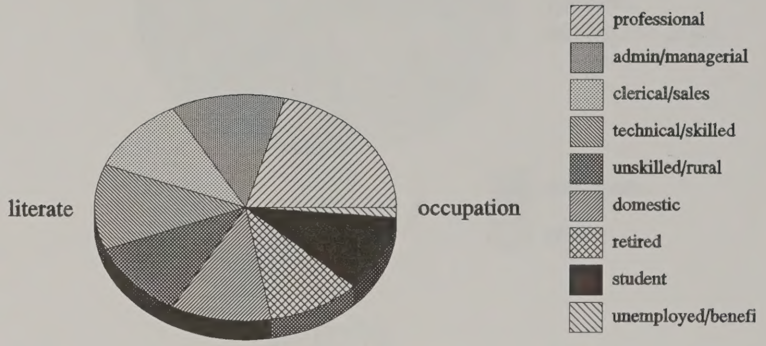

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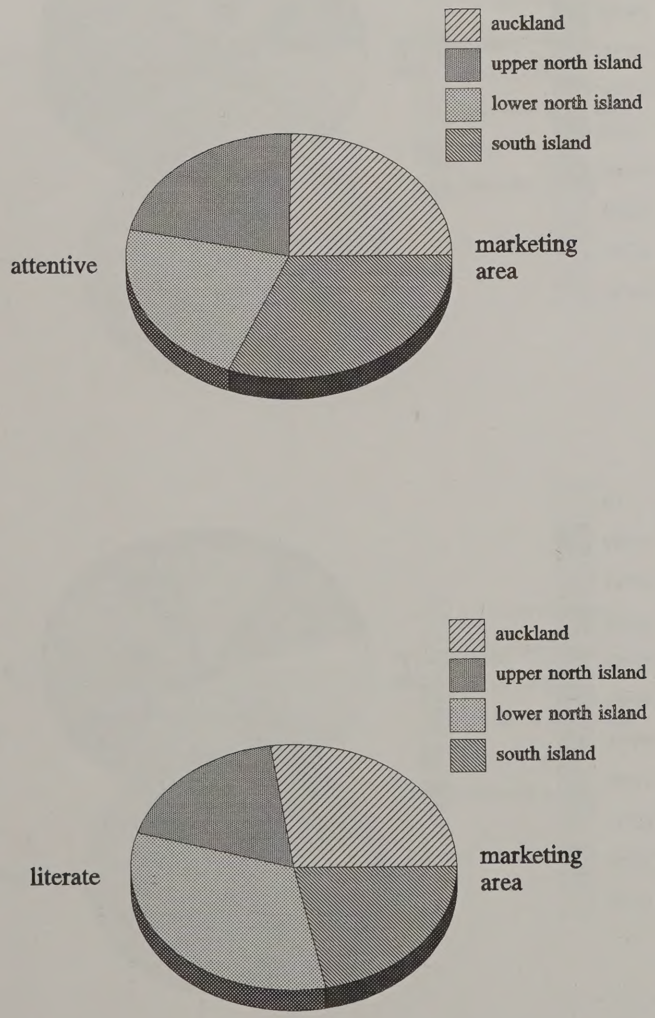

GRAPH 12